

- 9 -

REMARKS

Applicants' attorney thanks the Examiner for the telephone interview of April 20, 2004. This amendment follows the outcome of that interview. Claims 1, 2, 4-7, 9-12, 14-17, 19-22 and 25-46 are pending in the application. Claims 1, 2, 4-7, 9-12, 14-17, 19-22 and 25-46 are rejected under 35 U.S.C. 112 first paragraph, as failing to comply with the written description requirement. Claims 1, 2, 4-7, 9-12, 14-17, 19-22 and 25-46 are rejected under 35 U.S.C. § 103(a) as being deemed unpatentable over U.S. Patent No. 5,699,440 (Carmeli) in view of U.S. Patent No. 6,052,124 (Stein *et al.*). Of the Claims, Claims 1, 6, 11, 16, 21, and 46 are independent Claims. The rejections are respectfully traversed and reconsideration is requested.

Regarding rejection under 35 U.S.C. 112

Claims 1, 2, 4-7, 9-12, 14-17, 19-22 and 25-46 are rejected under 35 U.S.C. 112 first paragraph, as failing to comply with the written description requirement. In response, claims 1, 6, 11, 16, 21 and 46 have been amended to remove the negative limitation. Removal of the 35 U.S.C. § 112 rejections to claims 1, 2, 4-7, 9-12, 14-17, 19-22 and 25-46 is respectfully requested.

Regarding rejection under 35 U.S.C. 103(a)

Claims 1, 2, 4-7, 9-12, 14-17, 19-22 and 25-46 are rejected under 35 U.S.C. § 103(a) as being deemed unpatentable over U.S. Patent No. 5,699,440 (Carmeli) in view of U.S. Patent No. 6,052,124 (Stein *et al.*).

Prior art methods for calibration, including the calibration method discussed in cited prior art Stein require some form of image feature, or registration between multiple images in order to extract camera parameters. In contrast, the Applicants claim a simple method for calibrating a camera without the use of specialized patterns or registration as required by the prior art. All that is required is a single blank piece of paper.

The applicants' claimed invention is directed to the use of camera defects that result in pixel intensity drop off in a digitized image to recover intrinsic parameters (e.g. focal length) of a camera. A blank piece of paper with uniform illumination is digitized. In a camera with no

09/298,372

- 10 -

defects, all pixels in the digitized image would have the same intensity. However, due to camera defects, there is a pixel intensity drop off in the digitized image. This pixel intensity drop off is based on geometric and optical defects of the camera. The pixel intensity drop off is caused by a vignetting effect (a reduction in illumination of image points at the edge of the image (*see* equation 14 in the applicants' specification)) which is geometric in nature (based on partial obstruction of light by the lens stop) and an off-axis illumination effect (illumination of the image point varies across the field of view in proportion to the fourth power of the cosine of the angle between the light ray and the optical path (*see* equation 5 in the applicants' specification)) which is optical in nature. The intensity of a pixel (image point) in the digitized image is dependent on a combination of these effects (geometric and optical).

The intrinsic parameters (e.g. focal length) of the camera are recovered using substantially only the pixel intensity drop off in the digitized image. One advantage of the Applicants' claimed calibration technique is that no special patterns are required. Thus, the Applicants' claimed technique recovers a camera intrinsic parameter from a single image of a blank textureless surface.

Cited prior art Carmeli merely discusses measuring the electro-optical performance representative of illumination uniformity based on evaluating the effect of vignetting on an output signal. (*See* Col 5, lines 52-57; Col. 6, lines 48-50; Col. 9, lines 52-61; Col. 11, line 16 and Col. 14, lines 7-18.) The intensity drop off measurement is the end result. There is no use of that measurement to recover (extract) another intrinsic parameter of the camera such as focal length. Carmeli does not discuss the effect of off-axis illumination. Carmeli merely discusses other tests that use test patterns with strong edges and contrast. Instead of relying on edges and contrast, the applicants' claimed calibration technique uses substantially only the pixel intensity drop off (intensity distribution) in the digitized image of a blank textureless surface having uniform illumination.

Carmeli does not use the result of the measurement of illumination uniformity to recover intrinsic parameters of the camera. Stein does recover intrinsic parameters of the camera. However, Stein uses specialized patterns to recover these parameters. The combination of Carmeli and Stein merely teaches use of specialized patterns to obtain intrinsic parameters,

09/298,372

- 11 -

storing the obtained parameters into a database and then using the parameters stored in the database to test the performance of the camera.

The foregoing patentable distinctions are recited in base claims 1 and 6 with the language or similar language:

"recovers an intrinsic parameter of the camera other than pixel intensity drop off based on substantially only the determined pixel intensity drop off"

Claims 4-5 and 9-10 are dependent on base claims 1 and 6 respectively and thus include this limitation over the prior art. Independent claim 11 recites a like distinction in terms of a computer system and thus similarly patentably distinguishes over the prior art. Independent claims 16 and 21 recite a like distinction in terms of an apparatus. Claims dependent on claims 11, 16 and 21 include this limitation over the prior art. Claim 46 includes like limitations distinguishing the cited art. New claims 47 and 48 are dependent on base claim 46 and thus follow.

Support for new claims 47 and 48 is found at least on Page 8, lines 12-15 in the applicants' specification as originally filed. No new matter is introduced. Acceptance is respectfully requested.

Accordingly, the present invention as now claimed is not believed to be anticipated by or made obvious from the cited art or any of the prior art. Removal of the rejections under 35 U.S.C. §103 (a) and acceptance of Claims 1, 4-6, 9-11, 14-16, 19-21 and 25-46 is respectively requested.

'09/298,372

- 12 -

CONCLUSION

In view of the above amendments and remarks, it is believed that all claims are in condition for allowance, and it is respectfully requested that the application be passed to issue. If the Examiner feels that a telephone conference would expedite prosecution of this case, the Examiner is invited to call the undersigned.

Respectfully submitted,

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Dated: 4/27/04